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1 **Delivering intensive rehabilitation in stroke: factors influencing**
2 **implementation**

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14

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18

1 **Abstract**

2 **Background**

3 The evidence-base for stroke rehabilitation recommends intensive and repetitive
4 task-specific practice, as well as aerobic exercise. However, translating these
5 evidence-based interventions from research into clinical practice remains a major
6 challenge.

7
8 **Objective**

9 To investigate factors influencing implementation of higher intensity activity in stroke
10 rehabilitation settings

11
12 **Design**

13 A cross-sectional qualitative study.

14
15 **Methods**

16 Semi-structured interviews with rehabilitation therapists who had experience of
17 delivering a higher intensity intervention as part of a clinical trial (DOSE), from four
18 sites, across two provinces, in Canada. An interview guide was developed and data
19 analysed using implementation frameworks.

20
21 **Results**

22 Fifteen therapists were interviewed before data saturation was reached. Therapists
23 and patients generally had positive experiences regarding high intensity
24 interventions. However, therapists felt they would adapt the protocol to

1 accommodate their beliefs about ensuring movement quality. The requirement for all
2 patients to have a graded exercise test, and the use of sensors, e.g. heart rate
3 monitors, gave therapists confidence to push patients harder than they normally
4 would. Paradoxically, a system that enables routine graded exercise testing, and the
5 availability of staff and equipment contribute challenges for implementation in
6 everyday practice.

7

8 **Conclusions**

9 Even therapists involved in delivering a high intensity intervention as part of a trial
10 wanted to adapt it for clinical practice. Hence it is imperative that researchers are
11 explicit regarding key intervention components and what can be adapted to help
12 ensure implementation fidelity.

13

14 Changes in therapist's beliefs and system level changes (staffing and resources) are
15 likely to be required to facilitate higher intensity rehabilitation in practice.

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1 **Introduction**

2 In stroke rehabilitation, best evidence is for intensive repetitive task practice^{1,2}.
3 Intensity refers to the work rate, effort level, or metabolic demand of exercise. In
4 stroke rehabilitation, key aspects of intensity include number of repetitions and work
5 rate³. The number of repetitions is an important component driving functional
6 recovery and neuroplasticity, and may facilitate the upregulation of biomarkers such
7 as brain derived neurotrophic factor to promote motor and cognitive recovery^{4,5}. In
8 addition to increasing repetitions, aerobic exercise has been demonstrated to be
9 beneficial to improve both aerobic conditioning and walking capacity⁶. Therefore,
10 cardiovascular exercise methods that consist of functional tasks, such as walking,
11 have the potential to address both aerobic and repetitive task training elements.

12

13 Despite a range of robust evidence (including systematic reviews and meta-
14 analyses) in support of repetitive task training and aerobic exercise^{1,7-9} and the
15 inclusion of these type of interventions recommended in guidelines¹⁰⁻¹², the reality is
16 that most patients in stroke rehabilitation wards spend most of their time sitting or
17 lying, doing very little^{13,14}. A study by Rand et al¹⁵, found that patients in the sub-
18 acute stage post-stroke, walked a median of 63 steps during their inpatient
19 rehabilitation physical therapy sessions, equating to only a few minutes of walking
20 exercises and hence insufficient in terms of repetitions or work rate to drive
21 neuroplastic changes or improve aerobic capacity. This was echoed in an
22 observational study of therapy sessions which found patients spent a negligible
23 amount of time (2.8+/-0.9 min) in an aerobic training zone¹⁶. Despite the recognition
24 by physical therapists that aerobic exercise and hence higher intensity rehabilitation
25 is important, clinical implementation remains challenging¹⁷. A small number of

1 studies have explored this evidence-practice gap by exploring reasons for not
2 implementing intensive exercise^{17,18}. This study aims to do the opposite; to capitalize
3 on an opportunity to study the actual implementation of a high intensity intervention
4 delivered by front-line physical therapists as part of an on-going clinical trial.

5

6 The Determining Optimal post-Stroke Exercise (DOSE) study is a multi-site,
7 randomized clinical trial in progress that assesses the feasibility of implementing
8 intensive, task-specific, physical therapy during inpatient rehabilitation¹⁹. Participants
9 are individuals admitted to inpatient rehabilitation within the first 10 weeks post-
10 stroke (typically 2-3 weeks post-stroke) who meet study eligibility criteria (adult,
11 hemiparesis in the lower extremity, able to ambulate $\geq 5m$ with assistance, and able
12 to understand and follow directions). Participants are randomized into one of three
13 groups:

14 1. Standard Care: Standard physical therapy (PT) care

15 2. DOSE1: Standard PT care replaced by an innovative exercise program (1 hr/day)
16 that focuses on blending aerobic exercise within task-specific walking activities. At
17 least 30 minutes of this session was dedicated to upright gait-related activities in an
18 aerobic zone, while the rest of the time could address other aspects (e.g., upper
19 extremity function, transfers, etc).

20 3. DOSE2: Standard PT care replaced by two hr/day innovative exercise program
21 (same content as Group 2). One hour is completed in the morning and 1 hour is
22 completed after regular inpatient therapy hours.

23 Each treatment program is conducted five days/week for four weeks. The objective is
24 for participants to undertake progressive, graded exercises using repetitive functional
25 activities that challenge cardiovascular fitness, mobility, and balance. A heart rate

1 monitor (Mio Alpha) and step counters (Stepwatch Activity Monitor and Fitbit One)
2 were worn during the treatment sessions to monitor progression towards 30-60 min
3 of continuous mobility activities in an aerobic zone ($\geq 40\%$ heart rate reserve) using
4 the available equipment in a standard stroke rehabilitation setting (e.g., parallel bars,
5 treadmill). All participants received a physician supervised cardiac screening (graded
6 exercise test) prior to enrolment in the study.

7 The DOSE study is a multi-site study being undertaken across four provinces in
8 Canada. As opposed to many rehabilitation trials where interventions are delivered
9 by research therapists employed solely on the research project, the DOSE
10 intervention is being delivered by front-line clinicians (physical therapists and
11 rehabilitation assistants) as part of their usual clinical care (with financial
12 compensation for any treatment sessions conducted after regular inpatient therapy).
13 This study aims to utilise the opportunity to explore factors influencing
14 implementation of a high intensity intervention, using the DOSE intervention as an
15 exemplar, but obtaining insights about the realities of implementing this kind of
16 intervention per se into everyday clinical practice.

17 **Methods**

18 **Study Design**

19 A cross-sectional study design was used with data collected via semi-structured
20 interviews. Semi-structured interviews are a widely used form of qualitative
21 interviewing, utilising a topic guide which provides a framework for directed, though
22 flexible, open-ended questions²⁰⁻²³. The Standards for Reporting Qualitative
23 Research: A Synthesis of Recommendations was used²⁴.

24

1 **Participant Selection**

2 Eligible participants included physical therapists and rehabilitation assistants who
3 were currently using, or had previous experience of delivering the DOSE intervention
4 as part of a stroke rehabilitation clinical trial (ClinicalTrials.gov Identifier:
5 NCT01915368). Sites were included if they had more than five study participants.
6 Potential participants were identified through the lead investigator of the DOSE study
7 (TK) and invited by email to take part in a telephone interview. Those who responded
8 to the invitation and provided informed consent were put in contact with the research
9 team who conducted the interview.

10

11 **Data Collection**

12 The Normalisation Process Theory and the Consolidated Framework for
13 Implementation Research (CFIR) were used in the development of the interview
14 guide for the study (Appendix 1), based on an interview guide that was used
15 previously to evaluate the implementation of a stroke rehabilitation intervention ²⁵.
16 Normalisation Process Theory can be used to understand the dynamic processes
17 involved in enabling a new intervention to become embedded in routine practice²⁶,
18 such as the DOSE intervention. The CFIR provides a menu of constructs that have
19 been associated with effective implementation²⁷ and includes the domains:
20 Characteristics of the individuals (therapy staff), characteristics of the intervention,
21 inner setting (stroke rehabilitation settings), and outer setting (e.g. patients and
22 external policy factors).

23 The interviews were conducted by the lead author (LC) via telephone and Skype.
24 Participants were not known to the interviewer. Participants were informed of the

1 reason for the study, and were asked to consider their thoughts in relation to the
2 DOSE intervention, but also high intensity interventions in general, and how/ if they
3 should be implemented in clinical practice (outside of a research trial). Participants
4 were aware that the interviewer was not part of the DOSE research team and
5 wanted an honest perspective, to learn lessons for implementation and that
6 criticisms were welcomed. All participants provided written informed consent and
7 received a \$100 (CDN) honorarium to compensate them for their time.

8 The interview guide was reviewed and piloted with researchers (n=2), and physical
9 therapists (n=2). Interviews were digitally recorded and transcribed verbatim to
10 enable in-depth analysis.

11

12 **Researcher characteristics and reflexivity**

13 The interviewer is a clinician-scientist, being both an experienced researcher and
14 physiotherapist in stroke rehabilitation. As such, she was aware of a number of
15 potential issues which may influence how well the DOSE model is implemented. To
16 reduce any associated bias, two further qualitative researchers were involved in the
17 analysis and interpretation of the data. The second researcher was also a
18 physiotherapist, who trained as a Biomedical Health Scientist and specialised in
19 Human Movement (Master of Science). The third researcher had a background in
20 health and social services research, with no clinical training.

21

22 **Data Analysis**

23 Interview transcripts were imported into NVivo 11 for analysis. The CFIR was used to
24 code the data, with additional free codes developed where the coding frame was

1 considered to have gaps. The transcripts were coded separately by the first, third
2 and fourth authors. In order to establish a shared understanding and interpretation of
3 the coding framework, all three researchers coded the same single transcript. The
4 coded transcript was compared and any variance in interpretation of data and
5 application of codes was discussed to arrive at a mutual decision. Three further
6 transcripts were analysed separately and reviewed as a team to check for consistent
7 interpretation and application of the coding framework, before remaining transcripts
8 were coded separately.

9

10 **Ethical Approval**

11 This study was approved by the relevant university research ethics boards (UBC
12 Behavioral Research Ethics Board H16-02449; UCLan Science, Technology,
13 Engineering, Medicine and Health Board STEMH 560).

14 **Results**

15 Twenty-three potential participants from four different sites were invited to take part
16 by email. On average the staff invited represented about a quarter to half the clinical
17 physical therapy team at each site, with the “evening” session included therapists
18 from not only the unit, but also within the health authority and greater physical
19 therapy and rehabilitation assistant community. Four people did not reply to the
20 email invitation and therefore the reasons for non-participation are unknown. In total,
21 from the 19 respondents, 15 interviews were conducted across four sites from
22 November 2016 to January 2017. Data collection ended upon achieving data
23 saturation, which was agreed through ongoing analysis by three researchers.
24 Participants were predominantly physical therapists (n=12), with three rehabilitation

1 assistants. .They had a mean age of 37 (SD 9.2) years, and had been qualified for
2 12.1 (SD10.0) years, specializing in neurology for 9.1 (SD 7.9) years. They provided
3 a mixture of the day and evening DOSE intervention sessions across all the 4 sites.
4 The 12 physical therapists were a mixture of seniority, with five having education to a
5 Bachelor's degree level, six to a Masters level and one doctoral level of education.
6 All participants felt they were working in a research supportive and research active
7 clinical unit.

8

9 Factors, derived from the CFIR, are summarised in Table 1. The most frequently
10 coded domain was the characteristics of the individuals (therapists) (187), followed
11 by the intervention characteristics (147), the inner setting (121) and then the outer
12 setting (62, of which 45 related to the patients).

13 <Insert Table 1 here>

14 These findings will now be detailed further, presented according to the CFIR
15 domains, together with supporting quotes. Participants are identified by their
16 participant code.

17 **Characteristics of the Individuals**

18 Individual's opinions towards the intervention played a large part in whether they felt
19 it was implementable. Their self-efficacy and stage of change also influenced how
20 likely they were to implement high intensity interventions. All therapists recognised
21 they were from research-active departments.

1 Generally, therapists were positive towards the concept of intensity, but were not
2 always sure how to actually deliver it:

3 D11 *“we’re very keen, I think, to increase intensity, we’re just not always sure how to*
4 *do it.... we want to exercise them because we know it’s good for brain recovery but*
5 *we’re worried about the heart and then we kind of go in circles”*

6 The beliefs of the therapists was a predominant factor influencing implementation, as
7 recognised by D10:

8 *“You wind up in this, what I think is an ethical dilemma of giving treatment that you*
9 *know follows the protocol but if you were using your own clinical sessions you would*
10 *not”*

11 Therapists were not specifically asked about their treatment approach, but most
12 people alluded to it. Five people mentioned a treatment approach, namely Bobath/
13 Neuro-developmental treatment²⁸, with only one stating they came from a Bobath
14 background, and four stating they were not Bobath trained. The approach was talked
15 about in terms that represented a belief system, for example, using terms like
16 devout, and pure:

17 D02: *“I’m not hard-lined pure Bobath at all, and I think that it is really important to*
18 *take on board things like more walking, more activity”*

19 This underpinned a conflict for most therapists between quantity versus quality of
20 movement, with not believing in Bobath meaning a therapist was more inclined to
21 implement high intensity interventions:

22 D10: *“I like the idea of getting people moving and refining the movement instead of*
23 *the Bobath approach of they can only do it if it’s perfect.”*

1

2 In terms of self-efficacy, therapists felt more confident in delivering higher intensity
3 interventions because of both the screening and monitoring involved with the DOSE
4 protocol. The graded exercise (stress) test was recognized as a key component of
5 the intervention, in that it both gave therapists the confidence to work patients at a
6 higher intensity, and also was used to define heart rate parameters for the patients
7 exercise intensity. This necessitates the requirement for heart rate monitoring to
8 objectively measure how hard patients are working:

9 D05: *"I just feel confident with the stress test, so there's that medical clearance. To*
10 *be able to push these patients to know they're able to achieve their max heart rate*
11 *without any concern"*

12 D03: *"the stress test ... it made me not nervous at all to treat patients"*

13

14 There were mixed opinions with regards to the implementation of higher intensity
15 interventions outside of the study, with most therapists stating they would adapt the
16 intervention. This was in terms of focus and how hard they would make patients work
17 gain better movement quality (or movement control) prior to walking:

18 D04: *I think I would still tend to hedge upon probably maybe stepping back a bit and*
19 *trying to get that better control before I did the treadmill walking"*

20 When asked about what they did after a patient finished the DOSE intervention but
21 was still an in-patient: D11:

1 *“No I did not usually carry on doing DOSE stuff. I kind of went back to things I like to*
2 *do.... I think I would still do some aerobic exercise, but not as much focus on always*
3 *the standing and walking pieces as we did with the DOSE.”*

4 However, some recognised their practice had already changed:

5 *D15: “people were like, “oh when you do this protocol it will change your practice”,*
6 *and I was like “oh will it really?”, and it really did. I don’t know I think they (other*
7 *therapists) have to do it themselves and then see the difference.”*

8

9 **Intervention Characteristics**

10 The importance of research evidence, seeing the effect of the intervention,
11 adaptability of the protocol and the use of the graded exercise test were main
12 contributors to the ‘intervention characteristics’. Therapists discussed evidence in
13 terms of clinically seeing an improvement, and there were conflicting opinions about
14 the importance of research evidence:

15 *D10: “a lot of the frontline therapists are not reading the primary literature. They’re*
16 *relying on somebody as a middle-man to tell them what the implementation looks like.”*

17 *D15: “I think the research is important. Like having articles come out that support it.”*

18 By being involved in delivering higher intensity interventions as part of a clinical trial,
19 therapists were given the opportunity to trial the intervention and reflect on their
20 current practice. Though there was recognition that the trial results had not been
21 published yet, generally therapists felt that higher intensity interventions were of
22 benefit for their patients and that they saw an improvement:

1 D10: *"It was amazing sometimes when I had patients that had a stroke two months*
2 *ago and they were getting more steps per day than most of the Canadian population"*

3

4 Therapists felt that to incorporate high intensity interventions outside of the study,
5 they may need to adapt the research protocol. There was conflict with the protocol
6 focussing on the whole task of walking with step and HR monitoring, with this being
7 the first part of the session. Some therapists thought that "pre-gait" activities (e.g.,
8 weight-shifting, standing, trunk exercises) were essential to benefit the quality of
9 walking, though recognised doing this first may reduce the intensity:

10 D13: *"one thing that I wasn't totally sold on for how the intervention happened was*
11 *just doing the walking first and then having more opportunity for the pre-gait later in*
12 *the session And I generally like the opposite, ... So probably the order I would do*
13 *differently if it was implemented."*

14 The therapists felt that since at least 30 minutes of the regular physical therapy time
15 was used for the DOSE protocol, and standard therapy time was not extended, they
16 still needed to accommodate all aspects of physical therapy, and sometimes there
17 was insufficient time to do this:

18 D11: *"It's hard with the DOSE to fit in, if people have a lot of upper extremity pain, if*
19 *you need to teach their family members transfers or practice stairs, do a home visit,*
20 *and do education. I had troubles fitting that in sometimes with the DOSE."*

21 Graded exercise test gave therapists the advantage of knowing they could push the
22 patient harder than they normally would have (termed by the CFIR as more radical).

23 Paradoxically, the need for a graded exercise test and the equipment (step and heart

1 rate monitors and ideally body weight supported treadmills) made the intervention
2 more difficult to implement outside of the study.

3 The frequency and duration of sessions was considered difficult to implement
4 outside of the study in terms of staffing:

5 *D12: "More staffing. ...with having the extra session there's only so many of us and*
6 *there's only so many hours in a day. So I definitely think if it was going to become a*
7 *practice that our staffing would have to really increase"*

8

9 Therapists liked the structure and graded progression of the DOSE manual and
10 paperwork, particularly tips and a bank of sample functional exercises that might
11 work for different patients. The structured format helped support different therapists
12 treating the same patients:

13 *D02: "It's really organized, everything seems to be set out so that its very clear. So*
14 *the packets with the patients is very self-explanatory, so if we're sharing care of the*
15 *patients with the physio that shows up for that day, it's very easy to find out what the*
16 *person did the day before"*

17

18 **Inner Setting**

19 Therapists recognised that in order to implement higher intensity interventions and
20 the pre-requisite of the graded exercise (stress) test, it would be important to have
21 sufficient resources, both in terms of staffing and equipment, with buy-in from the
22 whole team and good communication networks:

1 D12: *“with having the extra session there’s only so many of us and there’s only so*
2 *many hours in a day. So I definitely think if it was going to become a practice that our*
3 *staffing would have to really increase”*

4 D13, *“obviously the availability of the equipment affects how much you can really do*
5 *with your patients that are not in the study”*

6 D15, *“I think the team has to be all on board because it would be a big shift in how*
7 *we prioritize treatments and choose who to see and how we schedule them.”*

8 This also includes leadership engagement, to help ensure an environment which
9 was supportive and enabling change. Participants recognised they worked in
10 research intensive departments, which might be more open and supportive than non-
11 research active departments:

12 D10: *“to actually implement this, the way that it’s being designed right now, we would*
13 *need buy-ins from the administrative level to be able to do the stress testing and all*
14 *that”*

15 D12, *“Oh our manager is very into research and studies and looking into the future”*

16

17 Outer Setting

18 Type of patient, perceived patient’s need and external policy and guidelines played
19 important roles in the ‘outer setting’.

20 It was recognised that not all patients were suitable for high intensity interventions,
21 with therapists having opinions about who would benefit from this kind of intensity,
22 with it being particularly suitable for younger patients:

1 D11: *"I would want to include all sorts of different people, but there's got to be a way*
2 *to make it more digestible for someone who has never done exercise, because it*
3 *could be really scary"*

4 D07: *"So probably your younger population that were quite fit to begin with would be*
5 *all over that type of intensity."*

6 The patients themselves were thought to be positive towards the high intensity
7 intervention. Therapists were often surprised at how hard patients could work and
8 tolerate the intensive regime:

9 D12: *"I think the clients really enjoyed it too because they left feeling that they*
10 *accomplished a little bit of something that they were working hard on"*

11 D13: *"I was pleasantly surprised by how much they could push through"*

12 External Policy & Guidelines were also mentioned. The Canadian guidelines for
13 stroke state a graded exercise test should be undertaken which was recognised as a
14 challenge for implementation:

15 D11: *"based on what I understand from guidelines they would consider it (the stress*
16 *test) to be a necessity. I think the difficulty is that it's not realistic if you're thinking*
17 *about implementation and how to get it into practice.."*

18 D08: *I think it would have to be more resources given to the rehabilitation aspect of*
19 *the team and I think there has to be almost...it could be a provincial level or a federal*
20 *level overhaul of what rehab should be looking like for clients so that it can be*
21 *approved and the infrastructure can be changed and time would allow it"*

22

1 **Discussion**

2 The key factors that emerged to influence implementation were the therapists' beliefs
3 about the intervention, together with system level factors in terms of staffing and
4 access to resources such as the graded exercise test and monitoring equipment.
5 This had wide-reaching implications, as no matter how many positive trials are
6 undertaken, implementation is likely to stall without considering these wider issues.

7

8 Therapists wanted to change the content of the intervention when they implemented
9 it in their everyday practice. Generally this involved shifting the focus away from
10 quantity, more to quality (e.g. with pre-gait activities of part-tasks). Therapists are
11 autonomous practitioners, with their preferred treatment methods not necessarily
12 aligning with clinical practice guidelines. A recent study by Van Kessel et al²⁹, found
13 implementation of circuit class and seven-day therapy in stroke rehabilitation was
14 influence by individual beliefs rather than evidence. We must consider how we can
15 influence knowledge and beliefs, especially if publications have limited influence.

16 This challenge is worth considering when developing interventions and
17 implementation strategies, and perhaps needs to be considered more when
18 developing guidelines. Arguably, therapists in this study are 'early adopters'³⁰ and
19 more open to the concept of intensity than the wider population of therapists. The
20 demographics of the staff in terms of level of education and years of experience are
21 similar to those reported in other studies of stroke rehabilitation staff ³¹. However,
22 participants still clearly expressed conflict with quality versus quantity of movement,
23 and if or how they would continue to use high intensity interventions in their future
24 practice. This was less evident with those therapists who did not believe in the
25 Bobath approach. Being involved in the study and having opportunity to 'trial' the

1 intervention, was sufficient for some to change their beliefs. However, most intended
2 to step back or pare down the intervention when they would use it in clinical practice.
3 This highlights the importance of fidelity, and defining the key components and the
4 'adaptable periphery'³² to guide clinicians, as we know adaptations will happen (and
5 in fact facilitate uptake)³³. An example highlighting this in stroke rehabilitation is a
6 formative evaluation of the Graded Repetitive Arm Supplementary Programme
7 (GRASP)³¹, an evidence-based upper limb intervention³⁴. This found that although
8 the uptake of GRASP was good, key components of the intervention were modified
9 when implemented by therapists in routine clinical practice. For example, when the
10 GRASP was provided to non-stroke patients (e.g. spinal cord injury, brain injury
11 patients); the exercises were often provided separately as opposed to providing the
12 full manual, and the dose, when monitored, was less than the recommended
13 amount.

14
15 The graded exercise test was reported as key to enable therapists to safely deliver a
16 high intensity intervention, which echoed the findings in a recent Canadian survey¹⁸.
17 However, due to the resources required, this does pose a considerable barrier to
18 implementation. No studies to date have reported major adverse events that were
19 directly attributable to the cardiovascular training⁹, which presents questions whether
20 it is a necessary pre-requisite or more to guide target heart rate zones and give
21 therapists and patients the confidence to work harder. Existing guidelines are
22 contradictory, for example, the Canadian and American guidelines both recommend
23 graded exercise testing with ECG monitoring before beginning an exercise
24 program.^{6,12} Whereas the UK guidelines define aerobic exercise as; "Low to
25 moderate intensity exercise that can be sustained for long periods of time (e.g.

1 cycling, swimming or walking)” and do not mention the need for pre-exercise
2 testing.¹⁰

3

4 Changing clinical practice is notoriously difficult, with an often cited 17 year lag
5 between evidence getting into everyday practice³⁵. Rehabilitation interventions tend
6 to be complex interventions, i.e. interventions comprising several components acting
7 either independently or interdependently³⁶. Successful implementation of complex
8 interventions, such as DOSE, relies on changing the behaviours of those responsible
9 for their implementation³⁶ and is correspondingly complex. Behaviours do not occur
10 in isolation, but in a system, and as this study demonstrates, these are inter-related
11 and multi-factoral³⁷. Hence, in respect of trying to change clinical practice, it is not
12 always clear which factor(s) to target and which to target first. Michie et al ³⁷ propose
13 considering the likely impact of changing the behaviour, how easy it is to change and
14 the ‘spillover’ effect (positive or negative) on other behaviours. In rehabilitation, it is
15 not clear if the target should be at the level of the therapists (e.g beliefs) or system
16 factors (e.g. resources and staffing), or a combination of the two. Implementation
17 research is required to explore this.

18

19 **Limitations**

20 The data collected in this study relied on the healthcare professionals’ ability to recall
21 events from a few weeks to two years prior to the interviews. Participants in this
22 study were invited volunteers, thus introducing a self-selection bias where therapists
23 perhaps with stronger opinions on the programme and/or its implementation are
24 over-represented in the study findings. As the data is self-report in nature there is

1 also the risk of a social desirability bias. However, prior to, and during the interviews
2 it was highlighted to participants that the interviewer was independent to the DOSE
3 team, the data collected would be anonymised and that it would not be possible for
4 them to be identified in the hope that they would be as candid as possible. We
5 recognise that as an exploratory qualitative study, we have identified reported factors
6 but cannot assume causality.

7

8 Whilst there are a number of validated higher intensity exercise programs for
9 stroke^{38,39}, it is not clear at what point an intervention is 'ready' for implementation,
10 and it has been recognised that researchers should consider implementation
11 strategies *a priori*, ideally in partnership with the end users of the intervention.⁴⁰
12 Intensity per se is a key concept, and some of the issues are relevant to other
13 intensive rehabilitation interventions, such as repetitive task training and the quantity
14 versus quality debate.

1 **Conclusions**

2 Even therapists involved in delivering a high intensity intervention as part of a trial
3 wanted to adapt it for clinical practice. Hence it is imperative that researchers are
4 explicit regarding key intervention components and what can be adapted to help
5 ensure implementation fidelity.

6

7 Therapist’s beliefs on the need for pre-gait activities, as well as ensuring movement
8 quality pose barriers to implementing high intensity interventions in everyday clinical
9 practice. System level changes are likely to be required, in terms of staffing and
10 access to resources, to facilitate higher intensity rehabilitation in practice.

11

12 **Conflict of Interest statement:** The Authors declare that there are no conflicts of
13 interest.

14 **Authors' contributions**

15 The initial research proposal together with compiling applications for ethical
16 approval, and designing the interview guide was developed by LC with input from TK
17 and JE. Data collection was carried out by LC. LC, JJ, and CT undertook the
18 analysis. All authors contributed to writing up the findings, and critically reviewing the
19 final version for publication.

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- 16

1 Table 1: Factors influencing implementation of a high intensity intervention (DOSE)

Consolidated Framework for Implementation Research (CFIR)	
Characteristics of Individuals	
Knowledge and Beliefs	<ul style="list-style-type: none"> - DOSE fit better with some people's belief system than others due to conflict with quality of movement versus quantity of movement - Some people's beliefs changed once they had trialled the intervention
Self-Efficacy	<p>Therapists gained confidence to 'push people harder' due to:</p> <ul style="list-style-type: none"> - The graded exercise test making them confident patients had the 'all clear' - Seeing patients able to work harder - Using heart rate monitors and step counters as objective measures
Individual Stage of Change	<ul style="list-style-type: none"> - Most individuals were in the preparation or contemplation stage of change - Some recognised their practise had already changed - Others still felt they would 'step back' to their everyday clinical practice
Other Personal Attributes	<ul style="list-style-type: none"> - Most therapists had some previous exposure to research and were keen to be involved. - Two participants felt obliged to take part in the trial
Intervention Characteristics	

Evidence Strength and Quality	<ul style="list-style-type: none"> - Practical experience of using the intervention tended to outweigh publications. - Some mention of the importance of having underpinning research
Relative Advantage	Graded exercise test gave therapists the advantage of knowing they could push the patient harder
Adaptability	<p>Research protocol needs to be adaptable for clinical reality (e.g., more focus on upper limb/ education for some patients)</p> <ul style="list-style-type: none"> - Therapists thought that “pre-gait” activities were essential, though recognised doing this first may reduce intensity.
Complexity	<ul style="list-style-type: none"> - Graded exercise test and the monitoring of heart rates enabled therapists to push patients harder than they normally would have (more radical). - The need for a graded exercise test and the equipment make the intervention more difficult to implement - The frequency and duration of sessions was considered difficult to implement outside of the study
Design Quality and Packaging	- Therapists liked the structure and detail of the manual and paperwork, particularly tips and ideas.

	- The structured format helped support different therapists treating the same patients.
Inner Setting	
Structural Characteristics	- Concerns regarding staffing to enable the duration of therapy outside of the study - Shift required in how therapists prioritize treatment and buy-in from all therapists and managers when scheduling to allow for longer sessions.
Networks and Communication	- Communication important to ensure treatment schedules work to allow for longer sessions
Culture	- Recognition that these therapists worked in research intensive departments
Readiness for Implementation	- Leadership engagement recognised as important to support the resources required
Available Resources	- Need for graded exercise test, and ideally equipment (HR monitors, step counters, treadmills, harnesses)
Outer Setting	
Patient Needs and Resources	- Recognition that this type of intervention will not be suitable for all (especially elderly with co-morbidities). - Patients generally liked the high intensity and felt they accomplished something.

	- The therapists were surprised how hard patients worked and tolerated intensive regime.
External Policies and Guidelines	The Canadian guidelines for stroke state a graded exercise test should be undertaken which poses a challenge for implementation

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